BASELINE ASSESSMENT

WALLOPS FLIGHT FACILITY

INTRODUCTION

At the direction of the Office of Commercial Space Transportation (OCST), Research Triangle Institute (RTI) conducted a study of the Goddard Space Flight Center/Wallops Flight Facility (GSFC/WFF) at Wallops Island, Virginia. The purpose of the study was to establish a baseline upon which OCST could assess whether or not a commercial launch proposal is safe. Since the emphasis of the study is upon launch vehicles, particularly orbital launch vehicles, many activities at the WFF have not been treated with the same degree of attention. These range from a research airport with aeronautical research and airborne geoscience/applications programs to extensive activities associated with targets, drones and balloons, many of which are performed off range.

The following information is presented as a result of this effort:

A. GENERAL INFORMATION

1. Range History and Experience - In 1945, NASA's predecessor agency, the National Advisory Committee for Aeronautics (NACA), established a launch site on Wallops Island, Virginia, under the direction of the Langley Research Center, then a field laboratory station of NACA. This site was designated the Pilotless Aircraft Research Station and assigned the mission of conducting research to supplement wind tunnel and laboratory investigations into the problems of flight. When Congress established the National Aeronautics and Space Administration (NASA) in 1958 and absorbed Langley Research Center and other NACA field centers and research facilities, the Pilotless Aircraft Research Station became a separate facility - Wallops Station -operating directly under NASA Headquarters in Washington, D.C. It became Wallops Flight Center in 1974, and the name was changed to Wallops Flight Facility (WFF) in 1981 when it became part of Goddard Space Flight Center (GSFC), Greenbelt, Maryland.

Since 1945, Wallops has launched approximately twelve thousand suborbital research vehicles (sounding rockets and research balloons) in the quest for information on the flight characteristics of airplanes, launch vehicles and spacecraft, and to increase the knowledge of the Earth's upper atmosphere and the near space environment. Several hundred experiments are sent aloft each year. The launch vehicles, consisting of from one to four rocket stages, vary in size and power from the small Super Loki meteorological rockets to the four-stage Scout vehicle with orbital capability. To date, 21 orbital satellites have been launched on the Scout vehicle from Wallops as indicated in **Table 1**$_1$. An additional 19 suborbital Scouts have been launched carrying probes and reentry experiments.

TABLE 1. WFF SCOUT ORBITAL LAUNCH RECAP		
NAME	**DESCRIPTION**	**LAUNCH DATE**
S-56	Failed to orbit; second stage ignition malfunction	12/04/60
Explorer IX	For measuring atmospheric density and drag	02/16/61
S-55	Failed to orbit; third stage ignition malfunction	06/30/61
Explorer XIII	To determine the puncture hazard of micrometeorites which may be encountered by spacecraft	08/25/61
Explorer XVI	A second micrometeoroid satellite	12/16/62
Air Force Satellite	Geophysical Research satellite	06/28/63
Ariel II	United Kingdom satellite	03/27/64
Explorer XXIII	Another micrometeoroid satellite	11/06/64
San Marco I	First Italian satellite	12/15/64
Secor	U.S. Army geodetic satellite	08/10/65
Explorer XXVII	Beacon Explorer and geodetic satellite	08/29/65
Explorer XXX	Naval Research Laboratory IQSY Solar Explorer satellite	11/18/65
OV3-4	Air Force radiation detection satellite	06/10/66
Explorer XXXVII	Naval Research Laboratory solar radiation satellite (SOLRAD)	03/05/68
Orbiting Frog Otolith (OFO)	To study effects of weightlessness on inner ear along with "piggyback" Radiation Meteoroid satellite	11/09/70
Explorer 44	NRL SOLRAD-10C satellite	07/08/71
Eole	French weather satellite	08/16/71
Explorer 46	Meteoroid Technology Satellite (MTS)	08/13/72
Sage	The effects of aerosols and ozone on climate and environment quality	02/18/79
Ariel 6	British satellite - studies in the field of high-energy astrophysics	06/02/79
AF-16	Instrumented Test Vehicle for testing anti-satellite system	12/12/85

Also, approximately 142 sounding rockets have been launched over the past five years. They are listed in **Table 2**[2]. This is only a reflection of the NASA Sounding Rocket Program, not a comprehensive list of all sounding rocket launches.

Wallops is located on Virginia's eastern shore approximately 40 miles southeast of Salisbury, Maryland. The location of WFF in relation to nearby major population centers is shown in **Figure 1**[1]. It consists of three separate sections of real property:

(a) Main Base - Administrative offices, technical service support shops, a rocket inspection and storage area and an experimental research airport are located at the Main Base. In addition, there are such operational facilities as the Range Control Center, the main telemetry building, a large computer complex and the Management Education Conference Center.

(b) Wallops Island Launching Site - Wallops Island, a barrier island named after John Wallop, a 17th century surveyor, is located on the coast of Virginia approximately seven miles southeast of the Main Base. Separated from the mainland by two miles of marsh and inland waterway, the Island (approximately six miles long and about one-half mile at its widest point) is connected with the Mainland by a causeway and bridge. Located on the Island are launch sites, assembly shops, blockhouses, dynamic balancing facilities, some rocket storage buildings and related facilities.

(c) Wallops Mainland Site - Wallops Mainland, a half-mile strip at the opposite end of the causeway behind the Island, is the location for the long-range radars, communications transmitter facilities and command transmitters.[1]

2. WFF Organization - The Goddard Space Flight Center/Wallops Flight Facility is maintained and operated as a NASA research/test launch range. The Director of Suborbital Projects and Operations exercises overall jurisdiction and responsibility for all GSFC/WFF operations. The WFF organization is shown in **Figure 2**[3].

3. Wallops Launch Range - The Wallops Launch Range originates on Wallops Island, Virginia, and extends out into the Atlantic Ocean, utilizing the surface area and airspace above to conduct various flight operations. The principal Island facilities are those required to process, check-out and launch solid rocket boosters carrying scientific payloads on sub-orbital or low earth-orbit trajectories. Included are launch pads, launchers, blockhouses, booster preparation and payload check-out buildings, dynamic balance equipment, a timing facility, wind measuring devices, communications and control instrumentation, TV and optical tracking stations, surveillance and tracking radar units and other supporting facilities. Since the launch areas are located on the southern half of Wallops Island, most of the facilities mentioned here are in that area also, with special use facilities, such as balancing equipment, being located on the northern portion of the Island.

TABLE 2. NASA SOUNDING ROCKET LAUNCH RECAP			
FY Date	**Rocket Type**	**Range**	**Vehicle Success or Failure**
10-06-84	Nike Black Brant V	WSMR, New Mexico	S
10-22-84	Taurus Orion	WSMR, New Mexico	S
10-23-84	Taurus Orion	WSMR, New Mexico	S
12-10-84	Nike Black Brant V	WSMR, New Mexico	S
1-17-85	Aerobee 150	WSMR, New Mexico	S
1-23-85	Terrier Malemute	Sondre Stromfjord, Greenland	S
1-23-85	Black Brant X	Sondre Stromfjord, Greenland	S
1-28-85	Orion	Poker Flat, Alaska	S
2-7-85	Orion	Poker Flat, Alaska	S
2-8-85	Taurus Orion	WSMR, New Mexico	S
2-10-85	Terrier Malemute	Sondre Stromfjord, Greenland	S
2-10-85	Black Brant X	Sondre Stromfjord, Greenland	S
3-5-85	Taurus Orion	Sondre Stromfjord, Greenland	S
3-14-85	Taurus Tomahawk	Poker Flat, Alaska	S
3-15-85	Nike Orion	Fort Churchill, Canada	S
3-18-85	Black Brant V	WSMR, New Mexico	S
3-20-85	Taurus Tomahawk	Sondre Stromfjord, Greenland	S
3-20-85	Nike Tomahawk	Sondre Stromfjord, Greenland	S
3-22-85	Nike Orion	Fort Churchill, Canada	S
3-27-85	Nike Black Brant V	Fort Churchill, Canada	S
3-29-85	Nike Orion	Poker Flat, Alaska	S
3-29-85	Super Arcas	Poker Flat, Alaska	S

4-1-85	Nike Orion	Poker Flat, Alaska	S
4-1-85	Super Arcas	Poker Flat, Alaska	S
4-2-85	Orion	Poker Flat, Alaska	S
4-20-85	Nike Black Brant V	WSMR, New Mexico	S
6-14-85	Black Brant V	WSMR, New Mexico	S
6-24-85	Nike Orion	WFF, Virginia	S
6-26-85	Nike Orion	WFF, Virginia	S
8-3-85	Black Brant V	WSMR, New Mexico	F
9-6-85	Nike Orion	WSMR, New Mexico	S
9-7-85	Orion	WFF, Virginia	S
9-10-85	Orion	WFF, Virginia	S
9-10-85	Taurus Orion	WFF, Virginia	S
9-10-85	Nike Orion	WFF, Virginia	S
9-12-85	Nike Orion	WSMR, New Mexico	S
9-17-85	Orion	WSMR, New Mexico	S
10-16-85	Orion	WFF, Virginia	S
10-25-85	Nike Black Brant V	WSMR, New Mexico	S
11-10-85	Black Brant IX	Andoya, Norway	S
11-20-85	Taurus Nike Tomahawk	WFF, Virginia	S
12-14-85	Black Brant IX	WSMR, New Mexico	S
12-16-85	Black Brant IX	WSMR, New Mexico	S
1-18-86	Black Brant X	Andoya, Norway	S
2-1-86	Nike Black Brant V	WSMR, New Mexico	S
2-24-86	Black Brant IX	WSMR, New Mexico	S
2-26-86	Black Brant V	WSMR, New Mexico	S
3-7-86	Nike Black Brant V	WSMR, New Mexico	S
3-7-86	Taurus Orion	WSMR, New Mexico	S
3-13-86	Black Brant IX	WSMR, New Mexico	S
3-13-86	Black Brant V	WSMR, New Mexico	S
4-1-86	Black Brant X	Poker Flat, Alaska	S
4-3-86	Terrier Malemute	Poker Flat, Alaska	S
4-13-86	Black Brant X	Poker Flat, Alaska	S

4-18-86	Nike Orion	WSMR, New Mexico	S
4-22-86	Nike Black Brant V	WSMR, New Mexico	S
4-22-86	Black Brant X	WFF, Virginia	S
4-25-86	Nike Orion	WSMR, New Mexico	F
4-28-86	Taurus Nike Tomahawk	WFF, Virginia	S
5-13-86	Black Brant X	WFF, Virginia	S
5-13-86	Taurus Nike Tomahawk	WFF, Virginia	S
7-26-86	Nike Orion	Kiruna, Sweden	S
7-26-86	Nike Orion	Kiruna, Sweden	S
7-26-86	Nike Orion	Kiruna, Sweden	S
7-27-86	Super Arcas	Poker Flat, Alaska	S
7-29-86	Super Arcas	Poker Flat, Alaska	S
7-29-86	Super Arcas	Poker Flat, Alaska	S
8-2-86	Super Arcas	Poker Flat, Alaska	S
8-2-86	Super Arcas	Poker Flat, Alaska	S
8-24-86	Aries	WSMR, New Mexico	F
10-15-86	Nike Black Brant V	WSMR, New Mexico	S
10-22-86	Nike Black Brant V	WSMR, New Mexico	S
11-20-86	Orion	WFF, Virginia	S
12-15-86	Black Brant IX	WSMR, New Mexico	S
1-28-87	Black Brant IX	WSMR, New Mexico	S
1-31-87	Black Brant IX	Poker Flat, Alaska	S
2-17-87	Taurus Orion	WSMR, New Mexico	S
2-26-87	Terrier Malemute	Sondre Stromfjord, Greenland	S
3-5-87	Terrier Malemute	Sondre Stromfjord, Greenland	S
3-5-87	Taurus Nike Tomahawk	Sondre Stromfjord, Greenland	S
3-7-87	Black Brant X	Poker Flat, Alaska	F
3-21-87	Taurus Tomahawk	Sondre Stromfjord, Greenland	S
3-21-87	Nike Tomahawk	Sondre Stromfjord, Greenland	S

3-24-87	Nike Orion	WFF, Virginia	S
3-31-87	Black Brant IX	Sondre Stromfjord, Greenland	S
3-31-87	Taurus Nike Tomahawk	Sondre Stromfjord, Greenland	S
3-31-87	Taurus Nike Tomahawk	Sondre Stromfjord, Greenland	S
7-14-87	Super Arcas	Andoya, Norway	S
7-14-87	Super Arcas	Andoya, Norway	S
7-14-87	Super Arcas	Andoya, Norway	S
7-15-87	Taurus Orion	WFF, Virginia	S
7-15-87	Super Arcas	Andoya, Norway	S
7-26-87	Orion	WFF, Virginia	S
7-27-87	Taurus Orion	WFF, Virginia	S
7-27-87	Nike Black Brant V	WSMR, New Mexico	S
7-31-87	Black Brant IX	WFF, Virginia	S
8-7-87	Nike Black Brant V	WFF, Virginia	S
8-15-87	Black Brant IX	WSMR, New Mexico	S
9-27-87	Nike Black Brant V	WSMR, New Mexico	S
10-15-87	Orion	Andoya, Norway	S
10-15-87	Nike Orion	Andoya, Norway	S
10-21-87	Nike Orion	Andoya, Norway	S
10-21-87	Orion	Andoya, Norway	S
10-21-87	Nike Orion	Andoya, Norway	S
10-23-87	Nike Black Brant V	WSMR, New Mexico	S
10-28-87	Nike Orion	Andoya, Norway	S
11-12-87	Orion	Andoya, Norway	S
11-12-87	Nike Orion	Andoya, Norway	S
11-14-87	Black Brant IX	Woomera, Australia	S
11-18-87	Black Brant IX	Woomera, Australia	S
12-4-87	Black Brant IX	Woomera, Australia	S
12-11-87	Black Brant IX	WSMR, New Mexico	S
12-11-87	Black Brant IX	WSMR, New Mexico	S
1-19-88	Black Brant X	Poker Flat, Alaska	S

1-23-88	Black Brant IX	WSMR, New Mexico	S
1-29-88	Black Brant IX	WFF, Virginia	S
2-9-88	Black Brant IX	Poker Flat, Alaska	S
2-16-88	Black Brant IX	Woomera, Australia	S
2-28-88	Black Brant IX	Woomera, Australia	S
3-4-88	Black Brant IX	Poker Flat, Alaska	S
3-13-88	Black Brant IX	Woomera, Australia	S
3-17-88	Black Brant IX	WSMR, New Mexico	S
4-9-88	Black Brant V	Kiruna, Sweden	S
5-3-88	Nike Orion	WSMR, New Mexico	S
5-10-88	Nike Orion	WSMR, New Mexico	S
6-23-88	Black Brant IX	WSMR, New Mexico	S
7-27-88	Nike Black Brant V	WFF, Virginia	S
7-27-88	Taurus Nike Tomahawk	WFF, Virginia	S
9-10-88	Black Brant IX	WFF, Virginia	S
9-11-88	Black Brant IX	WSMR, New Mexico	S
9-15-88	Nike Black Brant V	WSMR, New Mexico	S
9-30-88	Special Projects	WFF, Virginia	S
10-20-88	Taurus Orion	Poker Flat, Alaska	F
10-24-88	Black Brant IX	WSMR, New Mexico	S
11-7-88	Black Brant V	Andoya, Norway	S
11-10-88	Black Brant V	WSMR, New Mexico	S
11-20-88	Black Brant V	WSMR, New Mexico	S
12-7-88	Nike Black Brant V	WSMR, New Mexico	S
12-17-88	Black Brant X	Andoya, Norway	S
1-9-89	Black Brant IX	WSMR, New Mexico	F
1-17-89	Black Brant IX	WSMR, New Mexico	S
1-30-89	Special Projects	Andoya, Norway	S

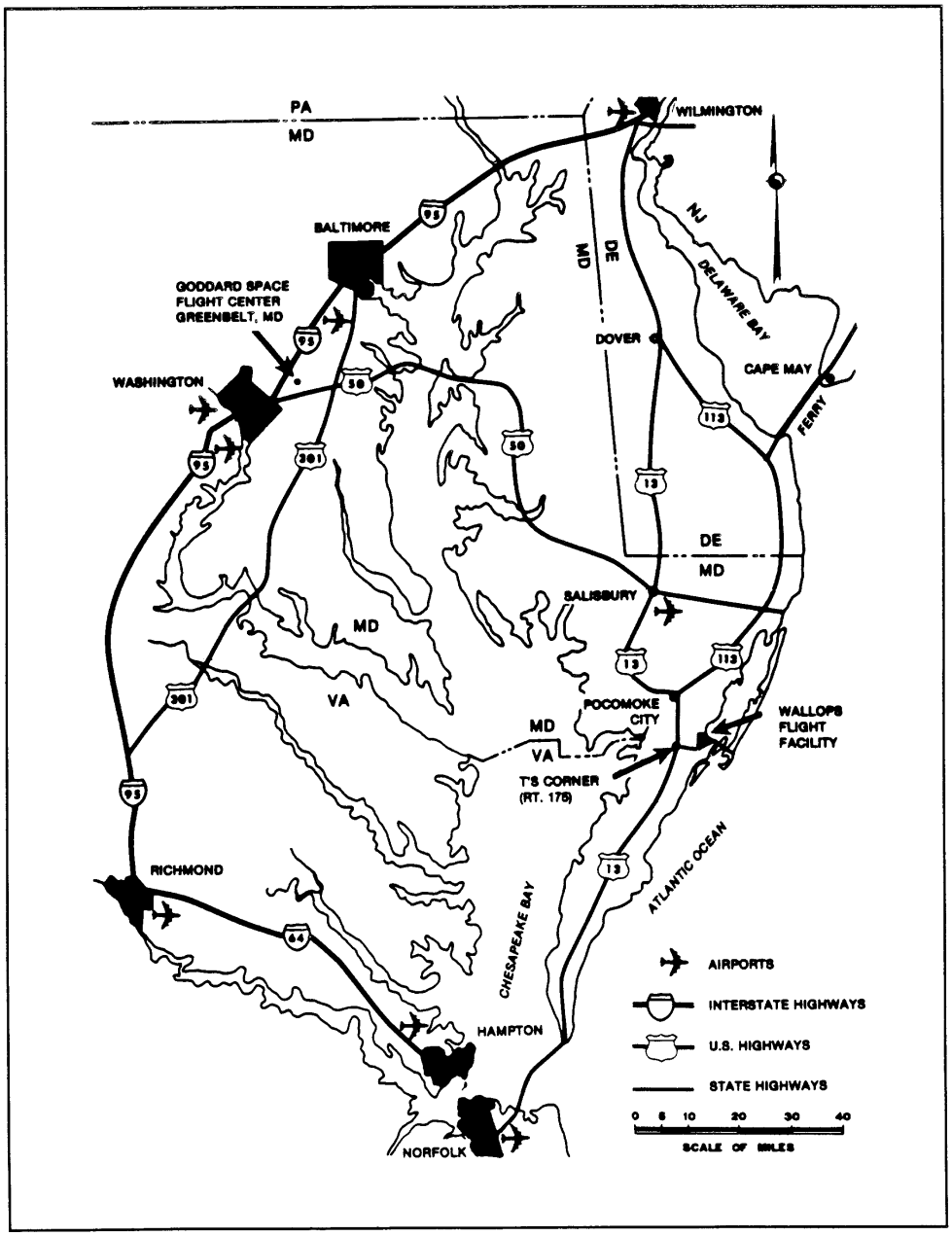

FIGURE 1. LOCATION OF WALLOPS FLIGHT FACILITY

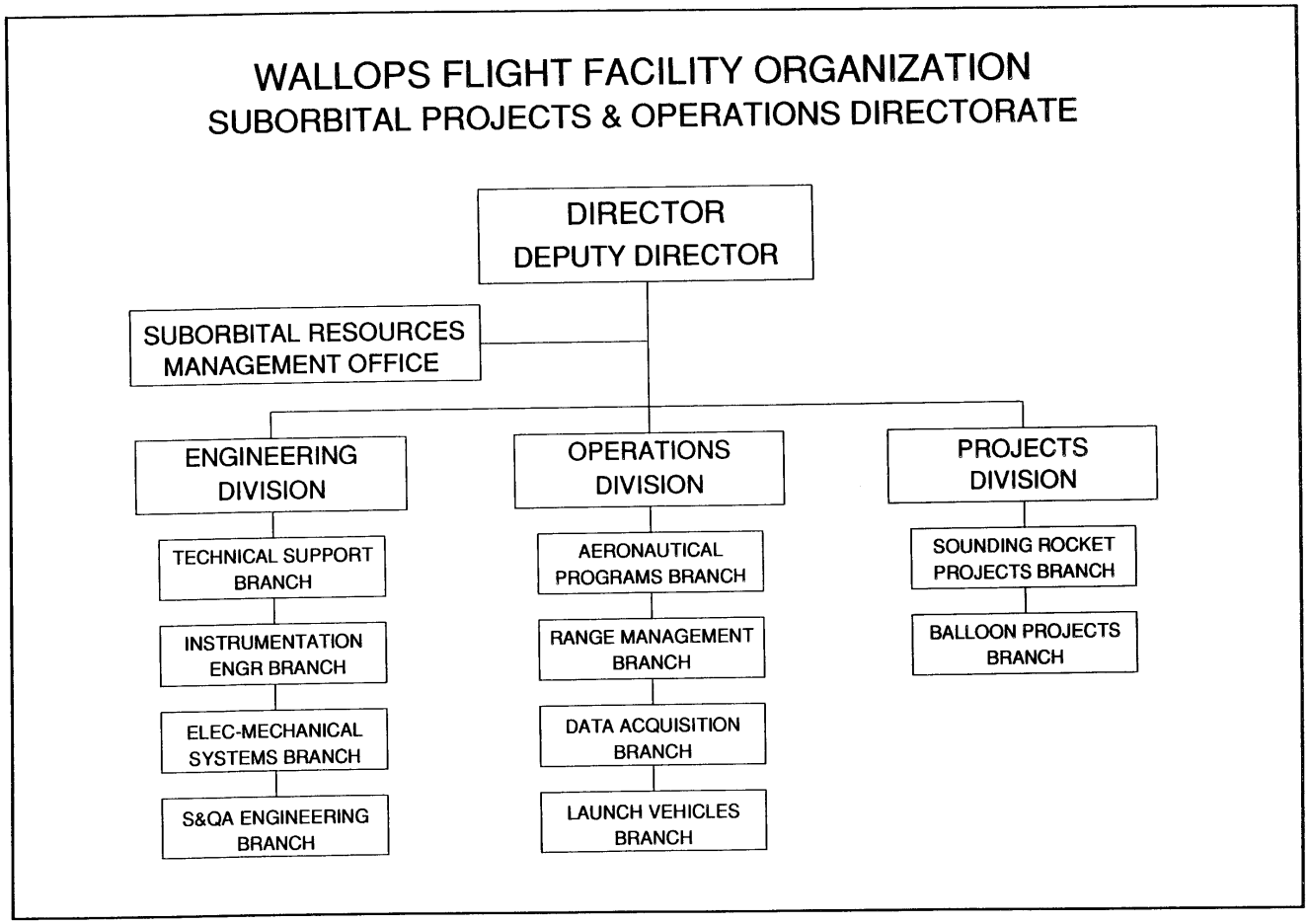

FIGURE 2. WALLOPS FLIGHT FACILITY ORGANIZATION

From time-to-time, ground-based scientific equipment requiring isolation from other activities may be located temporarily on the north half of the island.[1] **Figure 3**[1] shows the Wallops Flight Facility, Wallops Mainland and Wallops Island.

a. Complexes and Facilities - The WFF launch complexes are located on Wallops Island adjacent to the beach, see **Figure 4**[1] for WFF complex and facility locations, and consist of the following:

(1) Launch Area Number 0 - This area included one launcher (which has been removed), an assembly shop and a blockhouse. Large sounding rockets, such as Strypi, Super Chief and Black Brant were launched from a tubular launcher enclosed in a shelter. This site is currently inactive.

(2) Launch Area Number 1 - The launch tower at this site was 160 feet tall and could be adjusted in azimuth and elevation to the proper launch position (it has been removed). It was used primarily for launching the liquid-propellant Aerobee 150A vehicle, the Aerobee 350 (a larger version of the 150A), as well as the solid propellant Astrobee F and Black Brant V vehicles. The Aerobee sounding rockets were the only liquid-propellant vehicles launched from Wallops Island and were used for launching a variety of scientific experiments to gather information in the upper atmosphere, the ionosphere and space. This launch complex, currently inactive, is the prime candidate for refurbishment to support many of the commercial space activities planned in the future at Wallops Flight Facility.

(3) Launch Area Number 2 and Blockhouse Number 2 -Several types of launchers are located in this area since many types of vehicles carrying scientific experiments are launched from here. These include Nike-Cajun, Nike-Tomahawk, Orion, Nike-Orion and Black Brant sounding rockets as well as the small Arcas and Super Loki meteorological rockets.

(4) Launch Area Number 3 (Pads 3A and 3B) - Pad 3A is the pad from which the Scout vehicle has been launched in the past, and is located approximately one mile from the nearest waterway and 2 miles from the "public domain". It employs a horizontal type launcher which allows the vehicle to be prepared and held in the horizontal position until a short time before launch. At the proper time, the shelter building, which is mounted on steel tracks, is rolled away and the vehicle is elevated to launch position.

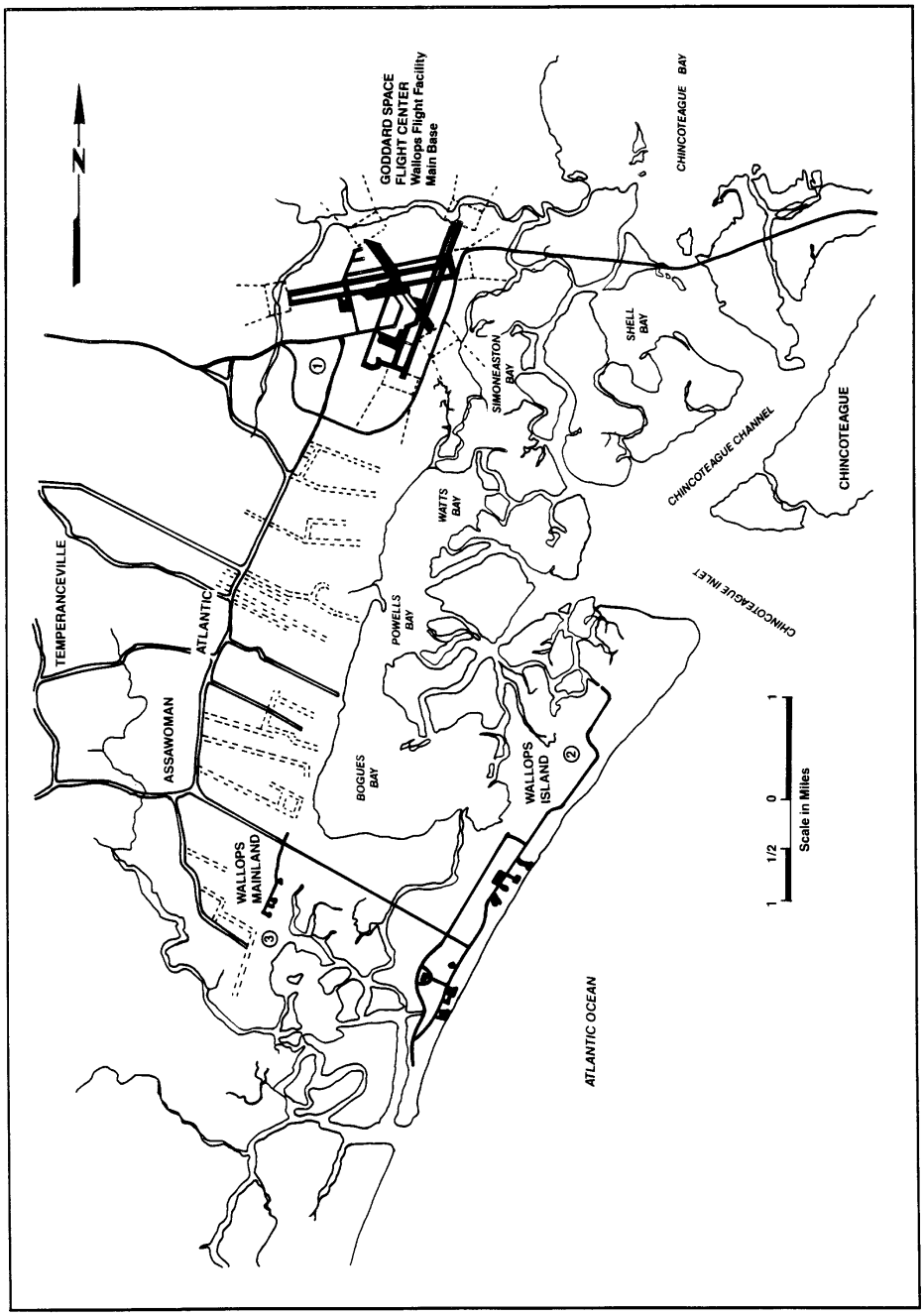

FIGURE 3. WALLOPS FLIGHT FACILITY

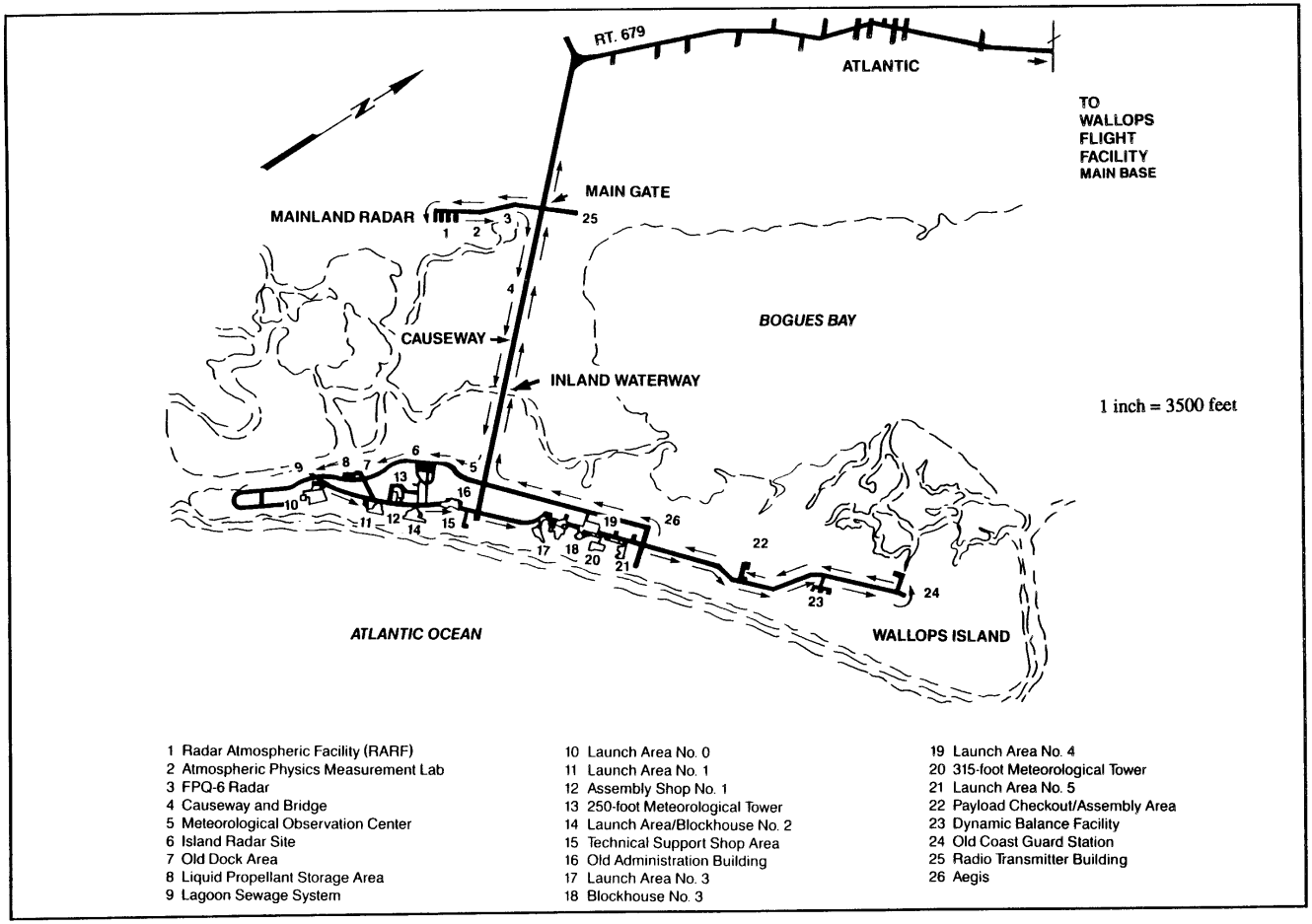

FIGURE 4. WFF COMPLEX AND FACILITY LOCATIONS

The Scout is the largest vehicle that has been launched at Wallops and is capable of performing a variety of missions, including the launching of satellites, space probes and atmospheric re-entry tests. Pad 3B is used for some of the larger sounding rockets and special purpose missions. **Figure 5**[4] shows the layout of the Scout launch area. Near the launcher is the Assembly Shop where the first three stages of the Scout vehicle are built up, assembled on the transporter and tested prior to transport to the pad area. In a parallel operation, the payload undergoes preparation and test in the payload facility, is transported to the Dynamic Balancing Facility and mated to the fourth stage. After dynamic balancing is performed, the payload/fourth stage is transported to the pad area for mating with the vehicle.

(5) Blockhouse Number 3 - This concrete dome-shaped building north of Launch Area No. 3 is the blockhouse from which operations on Launch Areas 3, 4 and 5 are controlled. The walls of this building are 8 feet thick reinforced concrete.

(6) Launch Area Number 4 - This area is used for sounding rockets and special projects.

(7) Launch Area Number 5 - The Vandal missile is launched from here and is used as a target missile for off-shore Navy surface warship defense system tests. Vandal is a two-stage supersonic missile about 22 feet long and 30 inches in diameter.

(8) General Support Facilities/Areas - In addition to the above, there is an assembly shop where all the sounding rockets are assembled, checked out and prepared for launch, a payload checkout and assembly area where both inert and "hot" payloads are assembled and checked out and other support facilities and shops.[1]

b. Instrumentation

(1) Radar - Radar systems track sounding rockets, balloons, space vehicles, satellites and aircraft to provide accurate velocity and positional data. The range of support provided by radar systems at Wallops can vary from tracking local aircraft in the vicinity of Wallops airport to tracking distant objects in space. Radar capabilities can be enhanced by laser tracking systems and sophisticated data processing systems to improve the precision and to record, analyze and process radar data. Some Wallops Flight Facility aircraft are radar-equipped to support experiments and operations by providing range surveillance and tracking. The radars at WFF operate in the UHF, X, S and C frequency bands.

(2) Telemetry - Both digital and analog telemetry transmissions are used at WFF. Almost all systems operate with S-band (2200 to 2300 MHz) downlinks and the UHF band for uplinks. A frequency of 1680 MHz is used occasionally for down links on some of the smaller sounding rockets. Bi-phase Pulse Code Modulation/Frequency Modulation (PCM/FM) and FM/FM are the two basic systems employed.

Telemetry data systems have the capability of providing positional data for the target. There are two 24-foot automatic trackers and two 8-foot automatic trackers. These are supported by antenna control and receiving stations, four

readout PCM stations, a digital PCM station and a meteorological station.

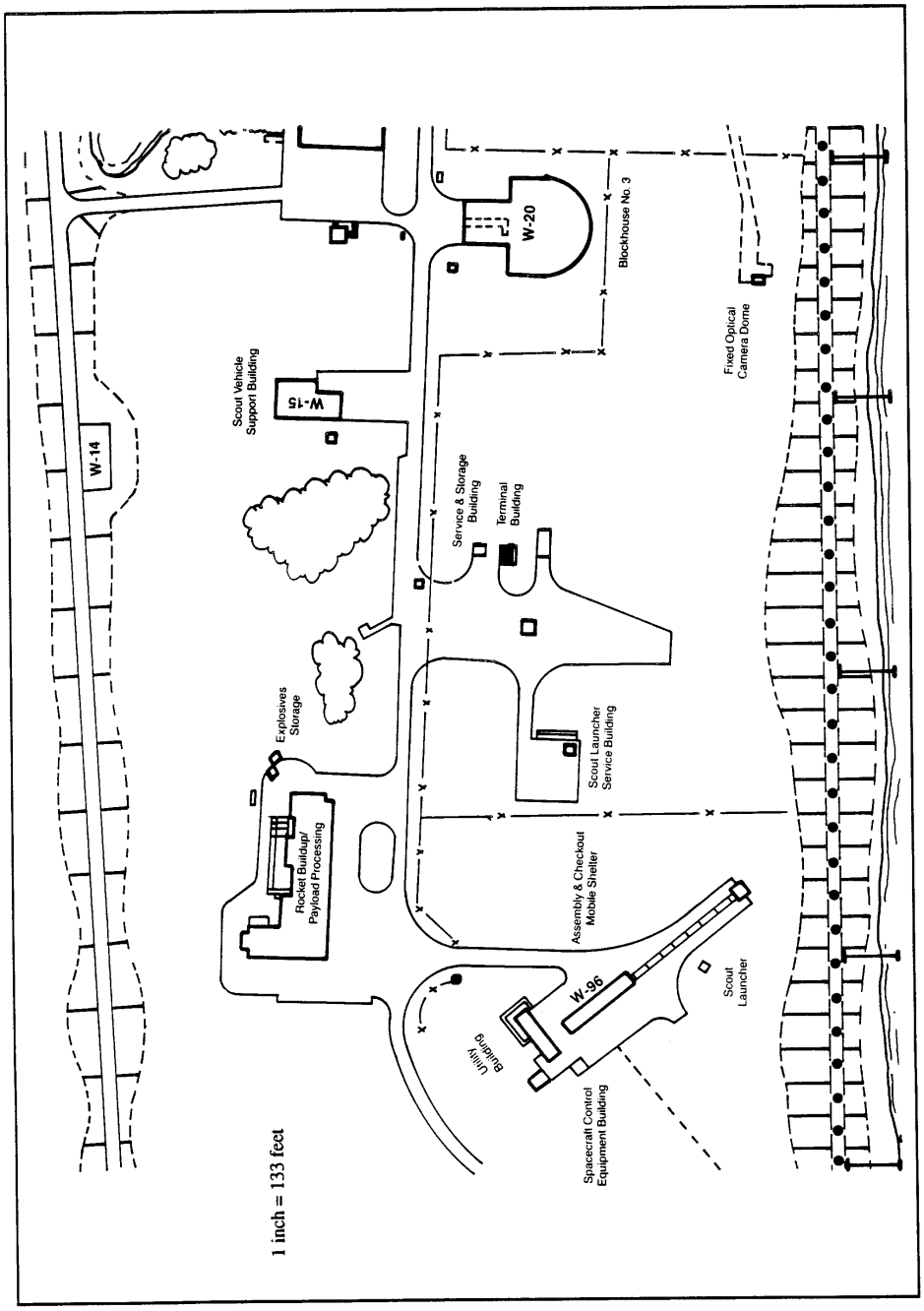

FIGURE 5. SCOUT LAUNCH AREA N0.3

(3) Data Systems - Data acquired during operations is processed by various computers at Wallops to provide information to experimenters and to support operations. A variety of data systems acquire, record and display information in real time for command, control and monitoring of flight performance.
(4) Communications - WFF operates ground-to-ground, air-to-ground, ship-to-shore and intra-station communications systems. These systems are composed of HF/VHF/UHF radios, cables, microwave links, closed-circuit television systems, command and control communications, frequency shift tone keying systems, operational teletype systems, high-speed data circuits and the WFF NASCOM Network terminal. Satellite communications and fiber optics are in growing use.
Communications provide the means for managing operations at Wallops and communicating and coordinating operations with related operations in other geographic areas (e.g. providing communications and tracking support for Space Shuttle operations at Kennedy Space Center).
(5) Command/Destruct - A Command/Destruct system allows ground control of airborne vehicle functions of on-board experimental devices. In addition, the Range Safety Officer (RSO) can terminate flight, in the event a malfunction presents a Range Safety hazard, of those vehicles equipped with a Flight Termination System.
(6) Optics - Remotely controlled television cameras monitor range operations and provide safety related information. Tracking cameras, including both film and a long-range video tracking system, provide visual information from remote locations for project and range support.
(7) Control Centers - There are two control centers at Wallops, located on the Main Base. The Airport Project Control Center controls experimental activities of aircraft using the Wallops Airport, and the Range Control Center controls launch, tracking and data acquisition operations. The control centers are focal points for communications, operational management and Range Safety. Vehicle operations, tracking and data acquisition are controlled and performance data is displayed on the Range Safety Display System and video monitors.
Communications with all participants in a mission provide the means for coordinating complex operations.